Beta Release Documentation

Kitchen Timer v1 - Phase B

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ENCE 3220 – Embedded Systems Design

Introduction

The purpose of this release is to introduce and document the creation of a kitchen timer for home use. The timer will be designed, printed, and manufactured according to specifications given by the customer.

Section 1: Project Requirements

In this section, the requirements set by the customer would be outlined. Given that this is a personal project for educational purposes, the requirements were set by the creator of the timer.

Hardware Requirements:

- Buzzer alarm
- 3 User buttons for increment, start/stop, and reset.
- 7-Segement display to show countdown.
- 2 Status LEDs to help functionality.
- 3D printed enclosure for the timer to sit in.

Software Requirements:

- Turn on and off the timer.
- Increment the timer.
- IoT capabilities to interact with the timer on a phone or computer.

Section 2: System Design

The chosen design considers all project requirements and utilizes a variety of components to make this possible.

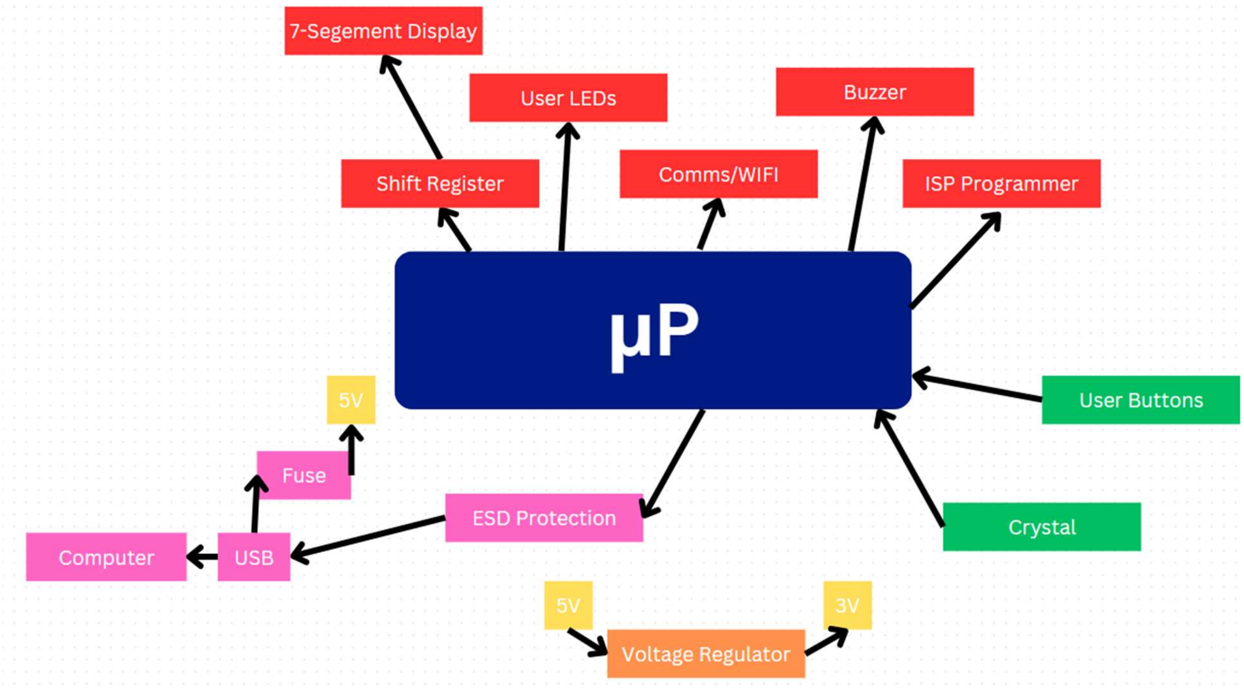

Figure 2.1 – Block Diagram of chosen design

With the desired outputs, consisting of buttons, LEDs, a buzzer, USB capabilities, and the number display itself, arises the need for additional hardware to allow the system to run smoothly. These additions include a voltage regulator, crystal oscillator to assist the clock, and capacitors to stabilize the microprocessor, which is the brain of the system itself.

Section 3: Components Selection

	A	B	C	D	E	F	G	H
1	**Component**	**References**	**Value**		**Footprint**			**Quantity**
2	Capacitor	C3, C5, C6, C7,	0.1uF		C_0603_1608Metric			8
3	Capacitor	C1, C2	22pF		C_0603_1608Metric			2
4	Capacitor	C10, C12	1uF		C_0603_1608Metric			2
5	Capacitor	C4	10uF		C_0805_2012Metric			1
6	Capacitor	C13	10nF		C_0603_1608Metric			1
7	Capacitor	C14	2.2uF		C_0603_1608Metric			1
8	Resistor	R5, R6, R7, R8,	100		R_0805_2012Metric			8
9	Resistor	R1, R2, R13, R1	10k		R_0603_1608Metric			4
10	Resistor	R3, R4	330		R_0805_2012Metric			2
11	Resistor	R15, R16	22		R_0603_1608Metric			2
12	Resistor	R14	1k		R_0603_1608Metric			1
13	LED	D1, D2, D3	LED		LED_0805_2012Metric			3
14	Display	U1	CA56-12EWA		CA56-12EWA			1
15	Shift Register	U2	74HC595		TSSOP-16_4.4x5mm_P0.65mm			1
16	Microprocessor	U3	ATmega32U4-A		TQFP-44_10x10mm_P0.8mm			1
17	Diode Safety	U4	USBLC6-2SC6		SOT-23-6			1
18	Voltage Regulat	U5	LP2985_3.3v		SOT-23-5			1
19	Crystal	Y1	16MHz		Crystal_SMD_Abracon_ABM8G-4Pin_3.2x2.5mm			1
20	Fuse	F1	PTCSMD		Fuse_1812_4532Metric			1
21	Button	S1, S2	PTS125SM43SMTR21M_LFS		PTS125_SMD_Button			2
22	Buzzer	LS1	Speaker		Buzzer_12x9.5RM7.6			1
23	Button	S3	PTS526_SM08_SMTR2_LFS		PTS526_SMD_Button			1
24	USB Connection	J1	USB_B_Mini		USB_Mini-B_Lumberg_2486_01_Horizontal			1
25	ISP Programmer	J2	AVR-ISP-6		PinSocket_2x03_P2.54mm_Vertical			1
26	WIFI Connection	J4	ESP_Conn		PinSocket_2x04_P2.54mm_Vertical			1

Figure 3.1 – Components gathered from BOM file, shown are all components used, their footprints, and quantities.

Components were selected based on their functionality in the design, their accessibility to the creator, and how they fit onto the board itself.

Section 4: Build Prototype

A prototype was first developed using the Arduino microprocessor and the Arduino Shield board placed on top. This timer included the basic components, LEDs, buttons, buzzer, and a display. The purpose of this prototype was to familiarize the creator with the hardware and software involved in the creation of a working kitchen timer. From this step, the WIFI module and new microprocessor will be implemented for wireless remote control of the kitchen timer.

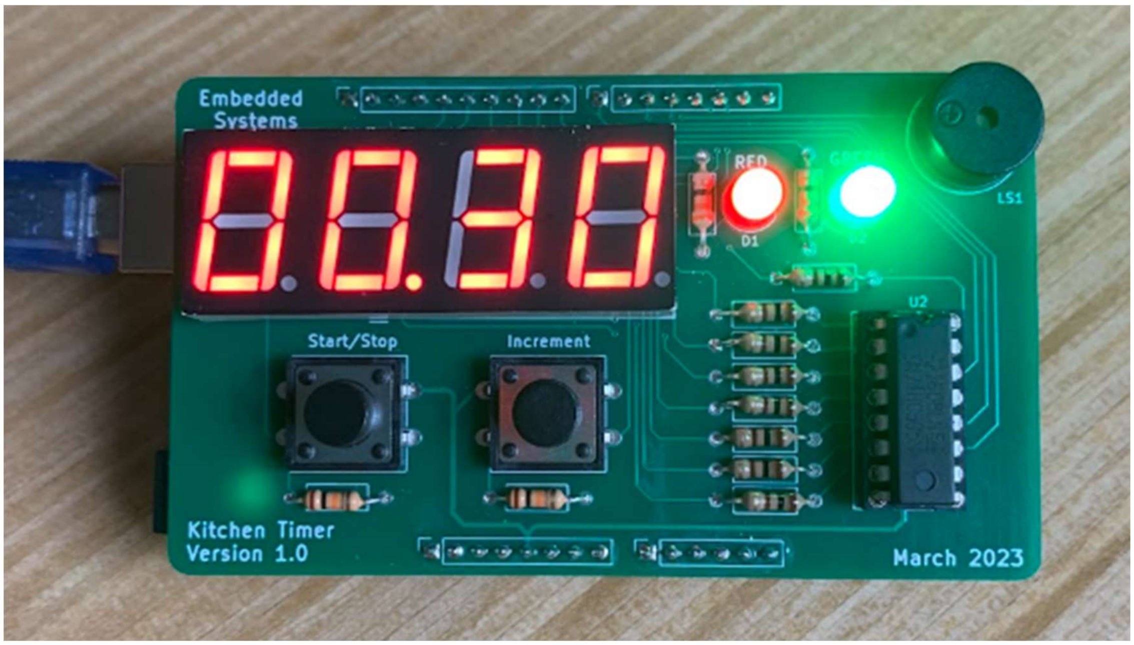

Figure 4.1 – Kitchen timer prototype using the Arduino Shield.

It can be noted that this design uses through-hole implementation of components. Another difference between this prototype and the final design will be surface mounted components.

Section 5: PCB Design

The printed circuit board designed for this prototype was created using the KiCad 7.1 software. This allowed for all the components to be designed, footprinted, and implemented onto a layout design.

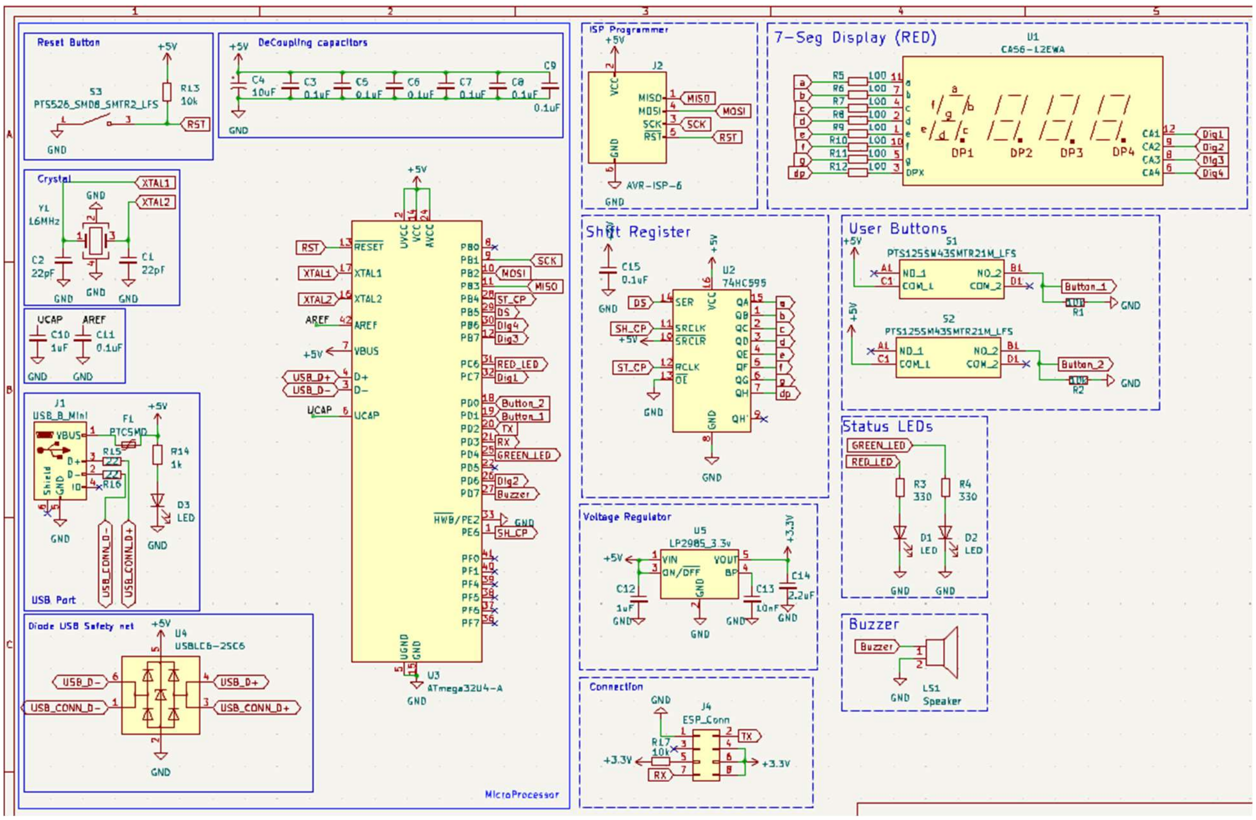

Figure 5.1 – KiCad schematic designed for the kitchen timer

The schematic figure displays the AT mega microprocessor, and all other related components and their connections. Tunnel flags were used to keep the schematic neat and easy to follow.

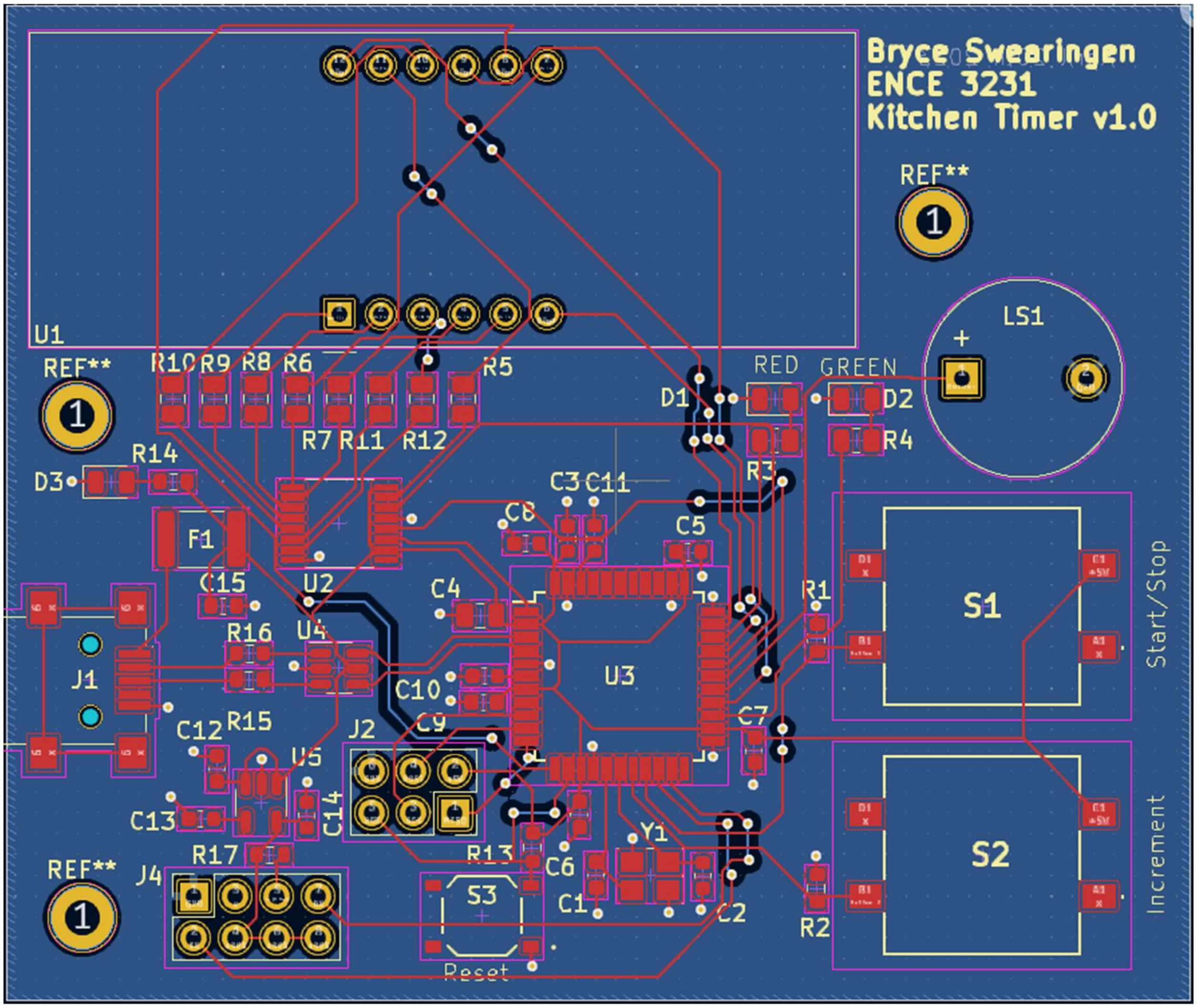

Figure 5.2 – Routing layout of kitchen timer PCB

The routing layout contains all connections between components, and the actual paths that the respective signals will take. This design contains 2 layers, a base ground layer, and a conductive copper top layer.

The component layout was decided on due to the attractive placement of buttons and LEDs, and also provided more simple routing paths with a centralized microprocessor.

The KiCad software allows for a 3D rendering to be created to visualize the component placement and routing paths, this is helpful to identify any overlapping components and wiring.

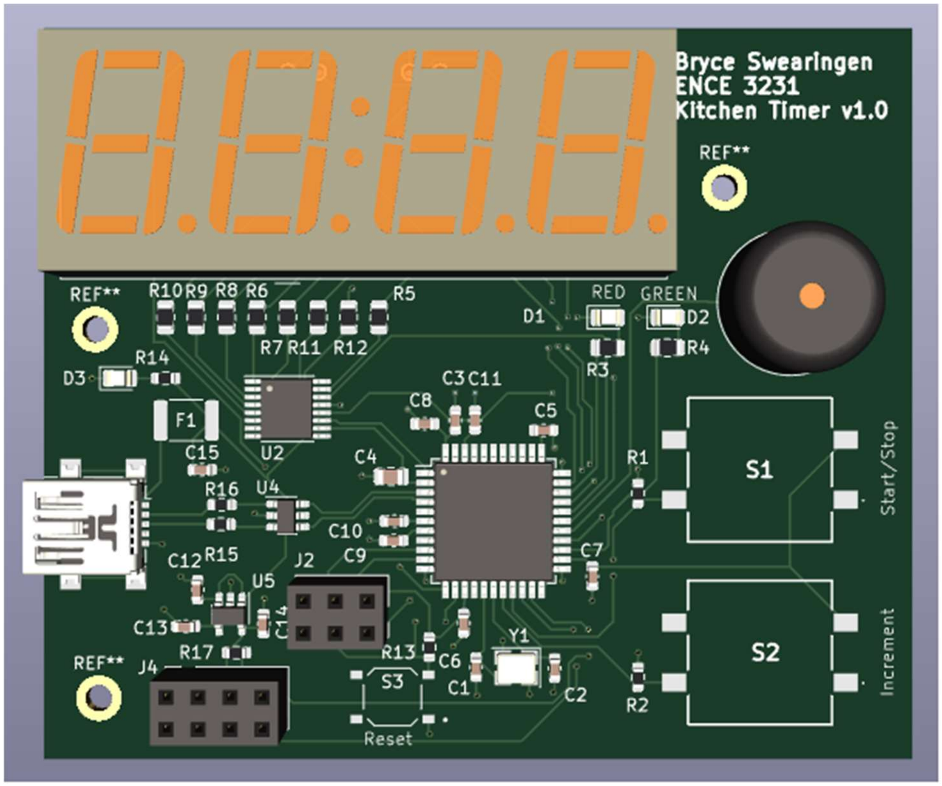

Figure 5.3 – 3D render of PCB front side

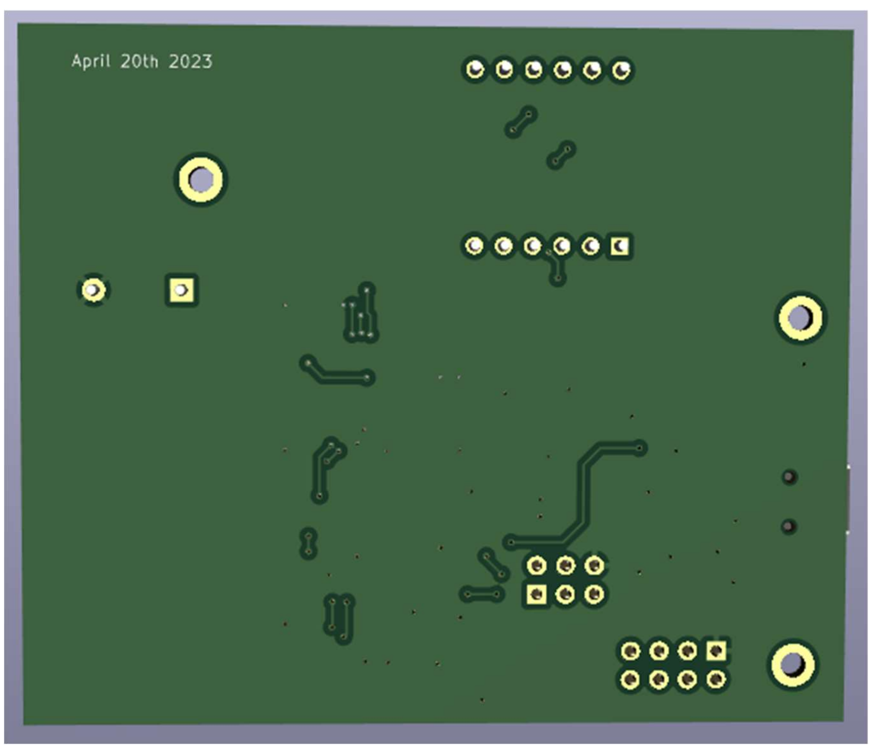

Figure 5.4 – 3D render of PCB back side

Section 6: Assemble Stage

The assemble stage consisted of three main portions.

- Component Soldering

The surface mounting components were soldered onto the printed PCB, providing valuable practice with soldering on a very fine level, and in-depth knowledge of each component and its purpose.

- Supplying Power and external components

Once the board was soldered, the external plug-ins were connected, this included the Wi-Fi module and USB connection. This allowed for the board to be tested and the connections to be verified.

- Casing and final implementation

Once the power and functionality is verified, the timer can be placed into its casing and is ready for use.

Section 7: Software Development

The software developed for this release can be split into 2 programs:

- Kitchen timer program

This program is the main logic for the function of the kitchen timer. Included are interrupt routines for the countdown, user buttons, and their corresponding outputs, the LEDs and the buzzer.

The program works by continuously decrementing the timer until an interrupt is encountered. The code will then filter the interrupt request into the corresponding output and proceed.

- Wireless connection program

The wireless connection program utilizes the external Wi-Fi module to provide a way to wirelessly interact with the kitchen timer. This code works to send and receive data by checking the available data in the serial buffer and prints that data to the serial monitor for the user to view.

This program will work in conjunction with the kitchen timer program in order to have the ability to wirelessly connect to the Wi-Fi module's network and set/reset the timer on the corresponding web page. The page will have start, stop, increment, and reset available.

Section 8: Enclosure design

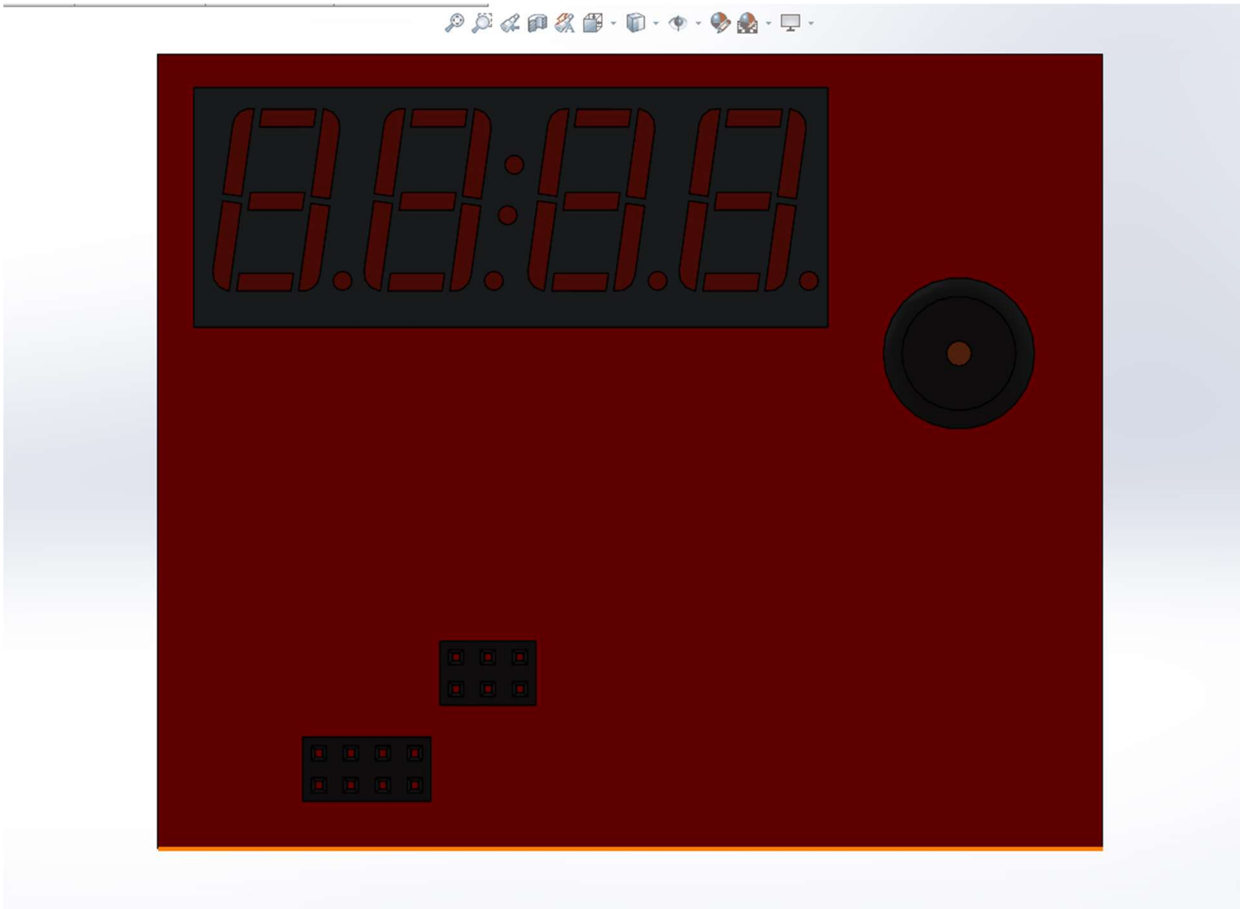

Figure 8.1 – Enclosure gif

The first draft of the enclosure contains housing for the timer to sit in, giving room for the external plug-ins. Further work is needed in the design of the enclosure, this includes a USB input hole, and accessibility to the connections located on the back of the PCB.

Finally, the enclosure will be 3D printed, the components will be soldered onto the PCB, placed in the enclosure, and the kitchen timer is ready for use. Happy cooking.